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Two records of *Ganoderma* new to mainland China

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Abstract — *Ganoderma applanatum* var. *laevisporum* and *Ganoderma multipileum* are first reported from mainland China. *Ganoderma chenghaiense* is found to be a synonym of *G. multipileum*. *G. applanatum* var. *laevisporum* is characterized by a rigid, sessile basidioma with a dull upper surface, yellow-brown to red-brown context, and smooth basidiospores 9.2–10.5 × 5.5–6.5 µm. *G. multipileum* is easily recognized by an orange-red to red-brown laccate pileus, pale brown to red-brown context, and finely echinulate basidiospores 9.2–10.0 × 6.2–7.0 µm.

Key words — distribution, East Asia, new record, polypore

Introduction

In a survey of species of the *Ganodermataceae* Donk reported from mainland China, two collections deposited in the Mycological Herbarium, Academia Sinica (HMAS), were of particular interest.

One collection from Guangxi was first identified as *Ganoderma applanatum* (Pers.) Pat. by Shu-Chun Teng, and later re-determined as *Ganoderma mirivelutinum* J.D. Zhao by Ji-Ding Zhao. Re-examination of this collection and comparison with the holotype of *G. mirivelutinum* designated in Zhao (1988) found that this collection from Guangxi is morphologically distinct from *G. mirivelutinum*, but identical to *Ganoderma applanatum* var. *laevisporum* based on the protologue in Humphrey & Leus (1931) and examination of one of two type collections of this variety.

The other collection from Guangdong is the holotype of *Ganoderma chenghaiense*. Re-examination of the types of *G. chenghaiense* in this survey

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and of *Ganoderma multipileum* in a previous study (Wang & Wu 2008) revealed that these two species are conspecific and the latter species has the priority of publication over the former.

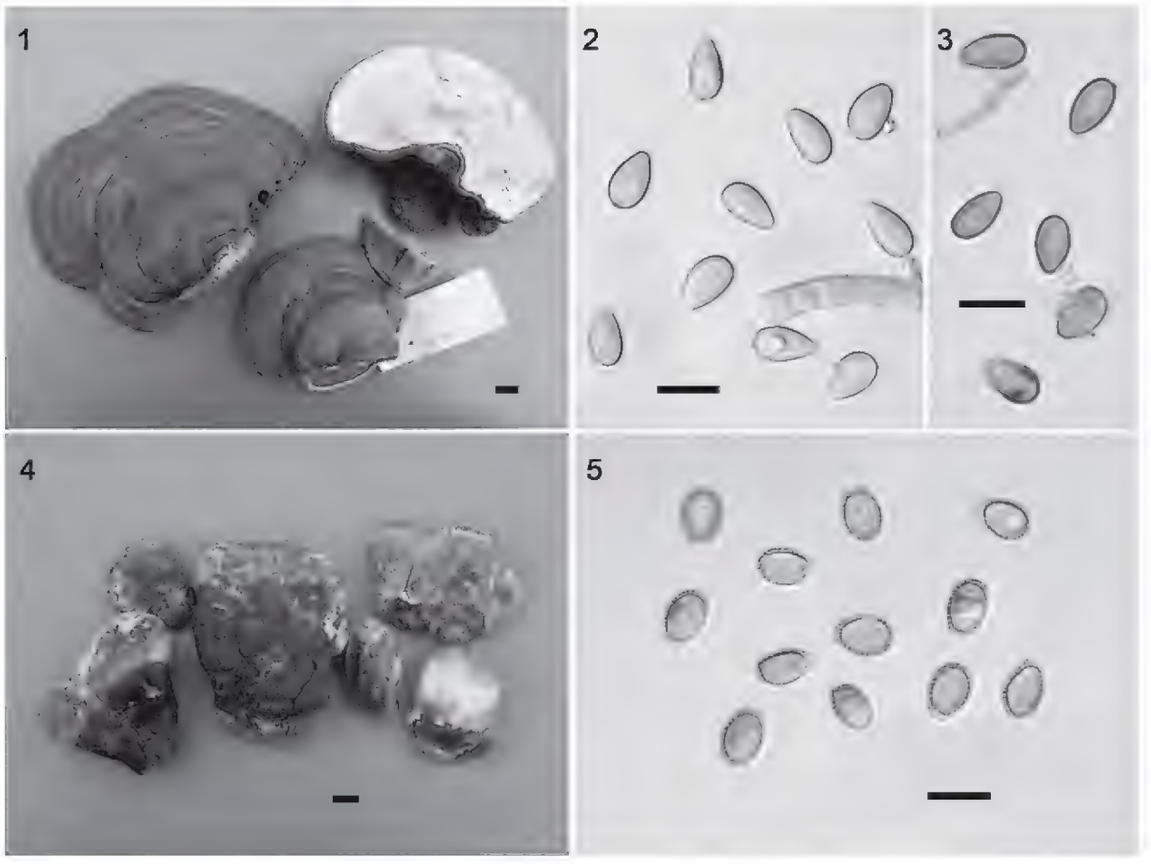
The methods for morphological studies mainly followed Wang & Wu (2007).

Taxonomy

Ganoderma applanatum* var. *laevisporum C.J. Humphrey, Philipp. J. Sci., C, Bot. 45: 533 (1931). Figs. 1–3.

Basidioma annual, sessile but with a slightly to distinctly contracted base, woody. Pileus 4.5–7.0 × 6.2–10.5 cm, up to 3.5 cm thick at the base, pulvinate; upper surface grayish white to brown, dull, with narrow grooves or not; margin obtuse, lobate or not, concolorous. Pore surface cream; tubes 1.5–9.0 mm long, yellow-brown; pores 5–6 per mm, circular or subcircular, 110–140 μm diam., dissepiments 30–70(–140) μm thick. Context 2.0–8.0 mm thick, yellow-brown to brown, tinged with whitened streaks or patches, corky; generative hyphae 2.5–4.5 μm diam., colorless, thin-walled, with clamp-connexions; skeleto-ligative hyphae 4.5–7.0 μm diam., yellow-brown to red-brown; binding hyphae *bovista*-type, 1.5–3.5 μm diam., colorless, solid, much-branched. Basidiospores 9.2–10.5 × 5.5–6.5 μm, ellipsoid or ovoid, apically non-truncate, lacking echinulation, dark brown. Cutis composed of red-brown solid hyphae, and colorless thick-walled hyphae intertwined, dextrinoid.

Specimens examined—**Mainland China: Guangxi**, Lingle county, Laoshan, on rotten wood, alt. 1700 m, 14 Dec. 1957, L.-W. Xu, 1240 (HMAS 20747; Originally identified as "*Ganoderma applanatum*" or "*Ganoderma mirivelutinum*"). **Taiwan: Chiayi**, Yushan National Park, Nanhsi Forest Road, 23°28′N, 120°54′E, alt. 1850 m, on trunk of living angiosperm, 13 Oct. 1993, S.-H. Wu & S.-Z. Chen, Wu 9310-26 (TNM F0001342; Originally identified as "*Ganoderma australe* (Fr.) Pat."); Yushan National Park, Nanhsi Forest Road, 23°28′N, 120°54′E, alt. 1800 m, on trunk of angiosperm, 13 Jun. 1996, S.-H. Wu & S.-Z. Chen, Wu 9606-45 (TNM F0005075; Originally identified as "*G. australe*"). **Hsinchu**, Between Chingchuan Checkup Post and Kuanwu, 24°32′N, 121°06′E, alt. 1400 m, on rotten trunk of angiosperm, 20 Nov. 1997, S.-Z. Chen, Chen 735 (TNM F0008859; Originally identified as "*G. australe*"). **Nantou**, Meifengshuiyuanti, 24°06′N, 121°10′E, alt. 2150 m, on rotten wood, 19 Feb. 1997, C.-C. Wen & S.-Z. Chen, CWN 02101 (TNM F0007463; Originally unnamed collection); Meifengshuiyuanti, 24°06′N, 121°10′E, alt. 2150 m, on rotten wood, 25 Apr. 1996, W.-N. Chou, CWN 01449 (TNM F0004942; Originally unnamed collection); Tsuifeng, 24°07′N, 121°12′E, alt. 2300 m, on stump of angiosperm, 16 Feb. 1993, S.-H. Wu, Wu 9302-56 (TNM F0001247; Originally identified as "*G. australe*"). **Taichung**, Anmashan, 24°16′N, 121°00′E, alt. 2250 m, on rotten trunk, 8 Nov. 1997, S.-H. Wu & H.-J. Chan, Wu 9711-43 (TNM F0009389; Originally identified as "*G. australe*"); Anmashan, 24°16′N, 121°00′E, alt. 2250 m, on rotten trunk of angiosperm, 8 Nov. 1997, S.-H. Wu & H.-J. Chan, Wu 9711-44 (TNM F0009993; Originally identified as "*G. australe*"); Anmashan, 24°16′N, 121°00′E, alt. 2100 m, on trunk of angiosperm, 6 Nov. 2003, S.-H. Wu et al., Wu 0311-3 (TNM



Figs 1–3. *Ganoderma applanatum* var. *laevisporum*. Fig. 1. Basidiomata (HMAS 20747); Fig. 2. Basidiospores (HMAS 20747). Fig. 3. Basidiospores (PC 0096710). Figs 4–5. *Ganoderma multipileum* (HMAS 50774). Fig. 4. Basidiomata; Fig. 5. Basidiospores.

Bars = 1 cm in F igs. 1 & 4; = 10 μm in F igs. 2, 3 & 5.

F0015693; Originally identified as "*G. australe*"). **The Philippines:** Luzon, Mountain Province, Bontoc Subprovince, Mt. Data, Mossy forest, Feb. 1928, M.S. Clemens (PC 0096710 = Bureau Of Science No. 50084, **Type**). The above description is solely based on the collection from mainland China. The type from The Philippines and collections from Taiwan are only used for the purpose of comparisons.

Distribution—Java and Philippine Islands (Humphrey & Leus 1931), Taiwan (Chang 1994), Mainland China (this study).

Notes—Humphrey & Leus (1931) proposed the variety, *G. applanatum* var. *laevisporum*, based on collections from Java (Tjibodas) and Philippine Islands (Luzon and Mindanao). Basidiospores with smooth inner and outer wall layers is a key diagnostic feature of this variety. Besides, the rigid, sessile basidioma with a dull upper surface, "Verona brown" (Ridgway) to "auburn" (Ridgway) or "bay" (Ridgway) context, and a distribution at higher elevations in the tropics or subtropics are also important features for identification. The Chinese collection cited above is considered to conform with these characters. Furthermore, its basidiospores (9.2–10.5 × 5.5–6.5 μm) are very close in size to those of the type collection of *G. applanatum* var. *laevisporum* PC 0096710 (9.3–10.3(–10.8) × 5.4–5.9(–6.4) μm) measured in this study.

Steyaert (1972) regarded *G. applanatum* var. *laevisporum* as a synonym of *Ganoderma tornatum* (Pers.) Bres. He found that smooth-walled spores can be observed in many species of *Ganoderma*, and their abundance may vary considerably from a small percentage to a majority of spores. His re-examinations of two collections cited by Humphrey & Leus (1931), part of Bureau of Science 50084 (one of two designated types) deposited in Paris and BO 705 from Java, showed that the Paris type (50084) has only a few echinulate spores in tube layer sections while the Javanese collection (BO 705) comprises two basidiomata, one lacking spores and the other with only echinulate spores. However, Humphrey & Leus (1931) proposed *G. applanatum* var. *laevisporum* based only on those specimens with smooth-walled spores, while observing echinulate spores in part of basidiomata of two of the collections cited in the protologue. We observed only smooth-walled spores (Fig. 3) from fragments of the type collection 50084 (= PC 0096710) that was studied by Steyaert (1972). Furthermore, a previous study of nine *G. applanatum* var. *laevisporum* collections from different localities in Taiwan revealed that smooth walls are a constant character, and the ITS sequences from three of those Taiwanese collections (data not shown) support the taxonomic position of this variety. Therefore, the present authors consider that *G. applanatum* var. *laevisporum* represents a distinct taxon that is independent of *G. tornatum*.

G. applanatum var. *laevisporum* also produces a perennial basidioma with a larger (12.0 × 12.5 cm) pileus and slightly longer (up to 11.0 µm) basidiospores in the Taiwanese collection Chen 735 (TNM F0008859). This taxon has been found on dead hardwoods (Chang 1994) or *Pinus insularis* (Humphrey & Leus 1931).

Zhao (1988) stated that *G. mirivelutinum* is characterized by the "flaskform velvet" on the upper surface of the pileus, formed from very numerous brownish thick-walled clavate cells. The collection from Guangxi HMAS 20747 has a pilear surface of distinct cuticular composition.

Ganoderma multipileum Ding Hou [as '*multipilea*'],
Q. J. Taiwan Mus. 3: 101 (1950). Figs. 4–5.
=*Ganoderma chenghaiense* J.D. Zhao, Acta Mycol. Sin. 8(1): 31 (1989).

Basidioma annual, sessile, corky. Pilei solitary or growing together, 3.8–5.0 × 5.0–6.2 cm, flabellate, or irregularly shaped; upper surface orange-red to red-brown, weakly to strongly laccate, non-sulcate, with fine wrinkles; margin thin, straw-yellow to orange-red. Pore surface yellow-brown; tubes up to 1.0 mm long, greyish brown; pores 6–7 per mm, mostly irregularly shaped, rarely circular or oblong, 70–150 µm diam., dissepiments 40–50 µm thick. Context 0.2–1.0 cm thick, pale brown to red-brown, with black crustose layer

in some basidiomata, corky; generative hyphae 3.5–5.0 μm diam., colorless, thin-walled, with clamp-connexions; skeleto-ligative hyphae 4.5–7.5 μm diam., yellow-brown to red-brown; binding hyphae *bovista*-type, 2.2–3.0 μm diam., colorless, thick-walled, much-branched. Basidiospores 9.2–10.0 × 6.2–7.0 μm (with myxosporium), 7.5–8.5 × 4.8–6.2 μm (without myxosporium), ovoid or ellipsoid, apically truncate or not, brown, with a dark brown eusporium with fine echinulae. Cutis composed of clavate elements, 25–40 × 6.5–12.0 μm, dextrinoid to slightly amyloid.

Specimens examined—**Mainland China: Guangdong**, Chenghai county, Oct. 1982, C.-J. Lin, 154 (HMAS 50774; Holotype of *Ganoderma chenghaiense*). **Taiwan: Taichung**, By Taichung Park, on stump, 7 Sep. 1949, Y.-F. Yu (TAIMF000001; Holotype of *Ganoderma multipileum*). The above description is solely based on the collection from mainland China. The collection from Taiwan is only used for the purpose of comparisons.

Distribution—Taiwan (Hou 1950, Wang & Wu 2008), Mainland China (this study).

Notes—Hou (1950) published *Ganoderma multipileum* based on a single collection from the lowlands in Taichung, Taiwan. This species has been recorded on the base or root of *Acacia confusa* (Chang & Chen 1986), and on the trunk of *Delonix regia* (Wang & Wu 2008). As suggested by the epithet "*multipileum*", Hou (1950) considered the multiple-pileate feature important in taxonomy. However, this characteristic is not reliable, as proved in the cultivation test of this species (Chang 1983). The most reliable criteria for recognizing *G. multipileum* are the basidiospore with fine echinulae, the orange-red to red-brown laccate pileus, pale brown to red-brown context, and the subtropical lowland distribution.

Zhao (1989) concluded that the features of a mostly tuberculate basidioma, and an irregularly shaped pileus are diagnostic of *G. chenghaiense*, when describing it as a new species. Furthermore, he mainly used the same characteristics to distinguish *G. chenghaiense* from another subtropical species, *Ganoderma tropicum* (Jungh.) Bres. However, basidiomatal appearance is taxonomically unreliable for *Ganoderma* species. *G. tropicum* differs from *G. chenghaiense* in having ovoid to broadly ovoid basidiospores with thick echinulae and a different ITS sequence (data not shown). *G. chenghaiense* is concluded to be synonymous with *G. multipileum* based on the finely echinulate basidiospores, along with other diagnostic features, e.g. pilear color, context color, and geographic distribution.

The holotype of *G. chenghaiense* comprises several basidiomata. They are immature, as indicated by having an incompletely developed pilear cuticle, or lacking hymenium. The type collection of *G. multipileum* also has incompletely developed basidiomata, but with slightly larger basidiospores, up to 12.0 μm long and 7.5 μm wide. The sizes of basidiospore and cuticle cells in mature collections might be larger than those measured in this study.

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